from the district which is faulted, and which shows distinct evidence of *very recent* elevation.

Second Report of the Committee consisting of Prof. P. M. Duncan and Mr. G. R. Vine, appointed for the purpose of reporting on Fossil Polyzoa; drawn up by Mr. Vine.—The order is divided into three subdivisions :—

1. *Cheilostoma*, Bark. = *Celleporina*, Ehrenberg.
2. *Cyclostomata*, ,, = *Tubuliporina*, Milne-Ed., Hagenow, Johnston.
3. *Ctenostomata*, ,,

The following terms are used in this Report in describing the genera :—

ZOARIUM.—"The composite structure formed by repeated gemmation" = Polyzoarium and Polypidom of authors.

ZOŒCIUM or cell.—"The chamber in which the Polypide is lodged."

CŒNŒCIUM.—"The common dermal system of a colony." Applicable alike to the "Frond," or "Polyzoary," of Fenestella, Polypora, Phyllopora, or Synocladia: or to the associated Zoœcia and their connecting "interstitial tubuli," of Ceriopora, Hyphasmapora, and Archæopora, or species allied to these.

FENESTRULES.—The square, oblong, or partially rounded openings in the zoarium—*connected by non-cellular dissepiments*—of Fenestella, Polypora, and species allied to these.

FENESTRÆ applied to similar openings, whenever connected by the general substance of the zoarium—as in Phyllopora, Clathropora, and the Permian Synocladia.

BRANCHES.—The CELL-bearing portions of the zoarium of Glauconome, Fenestella, Polypora, or Synocladia; or the offshoots from the main stem of any species.

GONÆCIUM.—"A modified zoœcium or cell, set apart for the purposes of reproduction."

GONOCYST.—"An inflation of the surface of the zoarium in which the embryos are developed." Modern terms from the Rev. Thos. Hincks.

Report of the Committee on Erratic Blocks, drawn up by the Rev. B. W. Crosskey.—Many additional instances of the occurrence of erratic blocks were recorded. Particulars were given respecting granite and sandstone boulders found while excavating for the new dock at Maryport, Cumberland. The granite specimens vary in size from small pebbles to a ton in weight, and are rounded. The New Red Sandstone boulders vary from half a ton to two tons or more, and have sharp angles. The nearest granite occurs in the Kirkudbrightshire Hills, on the other side of the Solway, fifteen or twenty miles distant; the New Red Sandstone is the stone of the district. A boulder of Shap granite found near Filey has been removed to the University Museum, Oxford. It rested on Oolitic strata at a height of about 150 feet above the sea. The nearest place where a granite of the same character is found is 108 miles distant, bearing west-north-west from Filey. The attention of the committee was drawn by Prof. T. McK. Hughes to a boulder of porphyritic hornblende diabase, near the centre of Anglesea. It is chiefly interesting as having been considered an inscribed stone, but the supposed characters are entirely due to rock structure. A detailed description of the great erratic called the "Holy Stone," at Humberstone, Leicestershire, was given. Its weight is about twenty-one tons. It rests on a denuded surface of the Rhætic formation. The height from which it travelled is about 400 feet above the sea, and is situated six miles north-west. The present height at which the block now rests is about 240 feet above the sea, and there is a river valley between these two points, running at right angles to the line of transit of the block, which is only 110 feet above the level of the sea. Various groups of boulders in Leicestershire were also described, some containing millstone grit blocks derived from Derbyshire, which must have travelled about thirty-five miles. A catalogue of 191 blocks in the parish of Ashwell, County of Hertford, was given. None of these blocks are local. Their general derivation is from the Oolites of the Midlands and from the Carboniferous and other rocks of more northern districts. The report concluded with an appeal to local observers to give assistance in cataloguing the rapidly-disappearing erratic blocks of the country.

Report on Thermal Conductivity of Certain Rocks, showing especially the Geological Aspects of the Investigations, by Prof. A. S. Herschel and Prof. Lebour.—This is the seventh and final Report of the Committee, and comprises a *résumé* of the results given in the preceding ones, with numerous additions and corrections. A bibliographical list of all papers on the subject, by Mr. J. T. Dunn, B.Sc., is given as an appendix. The apparatus and specimens employed during the investigations of the Committee are preserved in the museum of the College of Physical Science at Newcastle-on-Tyne.

SECTION A—MATHEMATICAL AND PHYSICAL

On the Possibility of the Existence of Intra-Mercurial Planets, by Balfour Stewart, LL.D., F.R.S.—It is a somewhat frequent speculation amongst those who are engaged in sun-spot research to regard the state of the solar surface as influenced in some way by the positions of the planets.

In order to verify this hypothesis observers have tried whether there appear to be solar periods exactly coinciding with certain well-known planetary periods. This method has been adopted by the Kew observers (Messrs. De La Rue, Stewart, and Loewy), who had an unusually large mass of material at their disposal, and they have obtained from it the following results :—

1. An apparent maximum and minimum of spotted area approximately corresponding in time to the perihelion and aphelion of Mercury.
2. An apparent maximum and minimum of spotted area approximately corresponding in time to the conjunction and opposition of Mercury and Jupiter.
3. An apparent maximum and minimum of spotted area approximately corresponding in time to the conjunction and opposition of Venus and Jupiter.
4. An apparent maximum and minimum of spotted area approximately corresponding in time to the conjunction and opposition of Venus and Mercury.

The Kew observers make the following remarks upon these results :—

"There appears to be a certain amount of likeness between the march of the numbers in the four periods which we have investigated, but we desire to record this rather as a result brought out by a certain specified method of treating the material at our disposal than as a fact from which we are at present prepared to draw conclusions. As the investigation of these and similar phenomena proceeds, it may be hoped that much light will be thrown upon the causes of sun-spot periodicity."

The Kew observers have likewise produced evidence of a different kind in favour of the planetary hypothesis, for they have detected a periodicity in the behaviour of sun-spots with regard to increase and diminution apparently depending upon the positions of the two nearer planets, Mercury and Venus. The law seems to be that as a portion of the sun's surface is carried by rotation nearer to one of these two influential planets, there is a tendency for spots to become less and disappear, while on the other hand, when it is carried away from the neighbourhood of one of these planets, there is a tendency for spots to break out and increase.

But whatever truth may be in these conclusions, it appears to be quite certain that periodical relations between the various *known* planets will not account for *all* the sun-spot inequalities with which we are acquainted. They may account for some, but certainly not for all. For there are solar inequalities of short duration which, presuming them to be real, can only be accounted for on the planetary hypothesis by supposing the existence of several unknown intra-Mercurial planets.

Indeed these short-period inequalities in sun-spots and the allied phenomena of terrestrial magnetism and meteorology have so augmented in number of late years as to make some observers inclined to question their reality; while others again resort to the above-mentioned hypothesis, and attribute them to intra-Mercurial planetary agency.

The method to be pursued in detecting the existence of inequalities will be easily understood by an illustration. Suppose that we had in our possession extensive records of the temperature of the earth's atmosphere at some one place in middle latitudes, and that, independently of astronomical knowledge, we were to make use of these for the purpose of investigating the natural inequalities of terrestrial temperature. We should begin by grouping the observations according to various periods taken, say, at small but definite time-intervals from each other. Now if our series of observations were sufficiently extensive, and if some one of our various groupings together of this series

should correspond to a real inequality, we should expect it to exhibit a well-defined and prominent fluctuation, whose departures above and below the mean should be of considerable amount.

Suppose, for instance, that we have twenty-four points in our series, and that we group a long series of temperature observations in rows of twenty four each, the time-distance between two contiguous members of one row being one hour. The series would thus represent the mean solar day, and we should without doubt obtain from a final summation of our rows a result exhibiting a prominent temperature fluctuation of a well-defined character, which we might measure (as long as we keep to twenty-four points) by simply adding together all the departures of its various points from the mean, whether these points lie above or below; in fine, by obtaining the area of the curve, which is the graphical representation of the inequality above and below the line of abscissæ taken to represent the mean of all the points. Suppose next that, still keeping to rows of twenty-four, we should make the time-interval between two contiguous members of a row somewhat different from one hour, whether greater or less, we should now in either case obtain a result exhibiting, when measured as above, a much smaller inequality than that given when the interval was exactly one hour; and it is even possible that, if our series of observations were sufficiently extensive, we should obtain hardly any traces of an inequality whatever.

In fine, when each row accurately represented a solar day, the result would be an inequality of large amount; but when each row represented a period either slightly less or greater than a day, the result would be an inequality of small amount. This process, as far as I have described it, is not new, inasmuch as something of this kind must be pursued in all attempts to detect inequalities. In the present instance we should by its means, after bestowing enormous labour in variously grouping, in accordance with a great number of periods taken at small intervals from each other, obtain definite results. These might be graphically represented in the following manner:—

The line of abscissæ might be taken to denote the exact values of the various periods, forming a time-scale, in fact, while the ordinates might represent the areas or summations obtained as above by employing these various periods. There would thus be in the case now used for illustration a very prominent peak, corresponding to twenty-four hours, which would fall off very rapidly on either side.

By means of the process now described we should at length, after enormous labour, obtain a graphical result, showing the exact position in the time-scale of the observed maximum inequality. In conjunction with Mr. William Dodgson, I have devised a method by which this labour is very greatly reduced, and the process so modified has been applied by us in order to determine whether there be inequalities of short period in the observed areas of the sun-spots occurring on the visible hemisphere of the sun. We have detected an inequality of this nature corresponding in period to 24·011 days, which, when subjected to a certain purifying treatment, appears to us to exhibit the marks of a true periodicity. But it has been suggested by Prof. Stokes that a method of this nature for detecting inequalities might with greater propriety be employed as a crucible for testing the value of some hypothesis introduced into it from without.

Acting upon this suggestion I have ventured to introduce the planetary hypothesis, and to ask whether the above sun-spot inequality of short period may not in reality be caused by an intra-Mercurial planet. It is quite easy to put this hypothesis to a test, taking for our guidance the results obtained by the Kew observers. For what do these results exhibit? In the first place they exhibit the probability of a sun-spot inequality corresponding to the period of Mercury round the sun; and in the next they exhibit the probability of similar inequalities corresponding to the synodic period of Mercury and Venus, and to the synodic period of Mercury and Jupiter.

Now if there be an intra-Mercurial planet of period 24·011 days, it will have the following synodic periods:—

With Mercury	... ...	33·025 days.
With Venus	... ...	26·884 days.
With Jupiter	... ...	24·145 days.

In conjunction with Mr. Dodgson I have applied the above method of analysis with the view of ascertaining whether there be well-marked sun-spot inequalities nearly corresponding to these periods, and we have obtained the following results:—

A very prominent inequality of period	...	32·955 days.
A very prominent inequality of period	...	26·871 days.
A less prominent inequality of period	...	24·142 days.

It will thus be noticed that there are prominent sun-spot inequalities, the periods of which agree very well with the synodic periods of the supposed planet with Mercury, Venus, and Jupiter, more especially if we bear in mind that this is only a first approximation.

The test, however, is not yet complete. Referring once more to the results of the Kew observers, it will be noticed that we have approximately maxima of sun-spot areas when Mercury and Venus, or when Mercury and Jupiter are in conjunction. Now if we assume that there is an intra-Mercurial planet of period 24·011 days, we are as yet unable to assign its exact position in ecliptical longitude at any moment. We know its period, and we may presume that it has considerable excentricity, but we know nothing else. We may, however, assume as most probable that the maximum point of the inequality of period 32·955 days corresponds to the conjunction of the planet with Mercury, the maximum point of the inequality of period 26·871 days to its conjunction with Venus, and the maximum point of the inequality of period 24·142 days to its conjunction with Jupiter. On this assumption, and knowing the average rate of motion of the planet in its orbit, we may deduce approximately its position at a given epoch independently from each of the three synodic periods above mentioned, and these positions ought to agree together, if our hypothesis be correct.

I have done this approximately, but am not able to bring exact figures before this meeting. The agreement is as great as can be expected, bearing in mind that we know only the average rate of motion of the planet, and not the variations of its rate, inasmuch as we are ignorant of its excentricity. I think I may state that three independent values of its position corresponding to January 1, 1832, will be obtained, and that the mean difference of a single value from the mean of the whole will probably not be more than twenty degrees. It would thus appear from this investigation that the evidence is in favour of the sun-spot inequality of 24·011 days being due to an intra-Mercurial planet. Of course a single research of this nature is insufficient to establish a theory of this importance, but as there are several short-period solar inequalities, the same method may be pursued for each, an operation which demands nothing but time and labour. It appears to me of great importance that these short-period solar inequalities should be systematically examined after this method.

The Effects of Gulf Streams upon Climates, by Dr. S. Haughton.—The author said that the Gulf Stream, and its counter current, the Labrador Current, produced important effects upon climate. The northern hemisphere was warmer than the southern from lat. 0° to lat. 30°, and it was colder than the southern from lat. 40° to 60°. The higher temperature of the southern hemisphere in the temperate latitudes was explained by the existence of three gulf streams in that hemisphere, while there was only one in the North Atlantic, and a partial one through Behring's Straits in the northern hemisphere. The general climatal effect of the Gulf Stream was therefore to make the annual range of temperature less, but it had no effect whatever upon summer heat, or upon the fruiting of plants and trees, that required a given July temperature for reproduction. The January temperatures in the North Atlantic at 70° were raised by the Gulf Stream, whilst the July temperatures remain unaffected. The effect of the cold currents, which were indirectly caused by the warm currents to preserve the proper condition of equilibrium, was nothing at all upon the January temperatures, but they lowered the July temperatures. The effect of the cold water was to lower the July temperature and to leave the January untouched, and the effect of the warm current from the south was to raise January and to leave July unaltered.

The Photographic Spectrum of Comet B 1881, by Dr. W. Huggins.—The author stated that in 1868 he applied the spectroscope to the light of comets, the result of his observations being to show the presence of carbon probably in conjunction with hydrogen in the cometary matter. Since then, until the present year, no comet of sufficient brilliancy to admit of observations being made had appeared. On the evening of June 24 last he directed the spectroscope to the head of Comet B with an exposure of an hour; and on the following night he obtained a second photograph with an exposure of an hour and a half. As it happened, the photograph which was the result of the longer period of exposure was the weaker of the two, but, taken together, an examination of the bands confirmed his

previous observations, and showed that part of the light of the comet was reflected sunlight and part original light; and further, that carbon was present in the cometary matter, with strong evidence also of the presence of nitrogen, in addition to carbon and hydrogen.

The Electric Discharge through Colza Oil, by A. Macfarlane, D.Sc., F.R.S.E.—The electrical properties of colza oil which I have examined are its dielectric strength and some phenomena which accompany the passage of the spark. By the dielectric strength of a substance I mean the ratio of the difference of potential required to pass a spark through air under the same conditions. The electrodes used were two parallel brass plates each 4 inches in diameter. When comparing the gases the standard distance of the plate chosen was 5 mm. In the case of liquids it is convenient to observe for a shorter distance, and reduce the result by the law which previous experiments of mine have established, namely, that in the case of the discharge between parallel plates through a liquid dielectric the difference of potential required is proportional to the distance between the plates (*Trans.* R.S.E., vol. xxix. p. 563). One set of observations gave the ratio for colza oil to be 2·7, another gave 2·5. Hence 2·6 may be taken. I have now obtained the following table of dielectric strengths for liquids (1 being unity).

Substance.	Dielectric Strength.
Paraffin oil	3·7
Oil of turpentine	4·0
Paraffin liquefied	2·4
Olive oil	3·5
Colza oil	2·6

The specific gravity of the colza oil is ·91. The passage of the spark was accompanied by the formation of gas bubbles, but there was no deposition of solid particles. As the 4-inch plates were placed horizontally in the oil a bubble produced by the discharge was prevented from escaping by the upper plate. When the upper plate is again electrified such a bubble behaves in the following manner. If it is large enough it will extend itself somewhat like an hour-glass between the plates, but if it is smaller it takes the form of an acorn with a flat base, the base resting on one or other of the plates. When the upper plate is charged positively the bubble is repelled so as to place its base on the lower plate; when the electricity is charged to negative the bubble remains with its base on the upper plate. A reversal of the order of charging did not change the effect. After a few electrifications a sufficient number of solid particles collect to form a chain, and thus interferes with the phenomenon, the bubbles then being lengthened out in a remarkable manner, but never repelled to the lower plate. When the upper plate was charged negatively, gas bubbles appeared to me to rise from the lower plate, as if they had been formed there. To test this point further I took some sparks between two smaller disks placed vertically in the oil. The gas-bubbles were observed to rise up at the negative surface as if they had been formed at the positive surface, and had been repelled or carried straight across, and then rose up at the negative surface. When the spark was taken between two points bent at right angles to two rods dipping into the oil, the bubbles were observed to shoot out in the direction from the positively charged point, and to circulate round the earth-rod some time before rising to the surface. These phenomena indicate that the bubble is positively electrified.

On the Electric Conductivity and Dichroic Absorption of Tourmaline, by Prof. Silvanus P. Thompson.—The electric conductivity of tourmaline differs in different directions; being, according to the author's experiments, a minimum along the optic axis. Tourmaline also possesses the optical property of dichroism, its absorption being a maximum for rays parallel to the axis, and greater for blue rays than for red, equal thicknesses of crystal being considered. According to the electromagnetic theory of light, bodies which are good conductors of electricity should be opaque to light. The author has in the August number of the *Philosophical Magazine* rewritten the equations of Maxwell's electromagnetic theory for the case of crystalline media possessing different conductivities in different directions. From these equations it appears that in tourmaline and negative uniaxial crystals electric displacements at right angles to the axis will be more absorbed than electric displacements parallel to the axis. This accounts for the well-known greater absorption of the ordinary ray, provided the views of Stokes and Fresnel are correct, that these displacements are at right angles to the so-called plane of polarisation. The difference of velocity between rays of different colour accounts for the difference of absorption being greater in that direction in which the conductivity is a minimum. It was also pointed out that in positive uniaxial crystals, in which the electric conductivity is a maximum along the axis, there will be maximum absorption of the extraordinary ray, and there will be least opacity along the axis. Smoky quartz and magnesic platinocyanide fulfil the latter condition. Specimens of tourmaline cut into cubes to show the colours in different directions were shown, and also specimens of magnesic platinocyanide and of herapathite. Mechanico-optical models were also shown illustrating the theory; a tourmaline being represented by a cube built up of layers of glass and wire-gauze. In conclusion it was shown that crystals in which the electric conductivity differs in three different directions will exhibit *trichroism*; and that di- or tri-chroic absorption is a general property of all coloured crystals other than those of the cubical system.

On the Application of Electricity to the Localisation of a Bullet in a Wound, by W. H. Preece.—The author showed how an electric current could be made an invisible and immaterial probe localising the position of a bullet in the human body without touching or giving the slightest sensation of pain. The conception of using electricity alone as the tool occurred to Prof. Graham Bell in Washington, who at once telegraphed to the author to consult him in reference to the use of Hughes' induction balance. In order to apply this apparatus to the localisation of a bullet in a wound, Prof. Hughes recommended that a pair of exploring coils should be made movable and portable, in order that they might be moved over the body of the wounded man. If the coils were brought within three inches of the bullet its presence could be detected, the direction in which the bullet was situated could be determined by observing the position of maximum sound, for in that position the bullet would be in a line with the axis of the coil. In order to ascertain the depth of the bullet a similar bullet is moved along in the direction of the axis of the other coil until neutrality is obtained; the depth of the trial bullet then will be equal to the depth of the buried one.

On the General Coincidence between Sun spot Activity and Terrestrial Magnetic Disturbance, by the Rev. F. Howlett, F.R.A.S.—The object of this paper was to inquire how far solar activity, more especially as regards sun-spots, is wont to be accompanied by terrestrial magnetic disturbances, as recorded by the automatic magnetic declination curves at Kew and Greenwich. The data for such an investigation were furnished by comparisons instituted between the most striking instances of sun-spots gathered out of a long series of solar observations carried on by Mr. Howlett from the year 1859 to the present epoch, and the synchronous conditions of the magnetic curves at the observatories above mentioned. The telescopic drawings of the spots were obtained with an achromatic of three inches aperture by Dollond, of forty-eight inches focal distance, projecting the sun's image on a large white screen in a darkened chamber. By employing a Huygenian eyepiece magnifying 120 linear, and placing the screen at the distance of five feet two inches from the eyepiece, a very distinct image of the sun was obtained of about five feet four inches in diameter, and of which every inch corresponded to just 30″ of the celestial arc. Not only were the measurements of all the solar phenomena rendered thereby exceedingly easy, but the conditions of amplification, illumination, and definition of details were combined in about the best possible manner for the observer's purpose, which was to maintain an accurate record of the solar spots, and very frequently of the faculæ also, on a large scale, and which have been collected into five volumes and presented to the Royal Astronomical Society. The comparisons commence with the very remarkable and cyclonic group of August, 1859, which was uniquely distinguished by the remarkable outburst of intense white light, far brighter than the photosphere itself, which fortunately was witnessed by the late Messrs. Carrington and Hodgson on the forenoon of September 1, but which Mr. Howlett missed seeing by only a few minutes, having completed his drawings, and left the telescope. Other striking and, if they may be so termed, crucial groups were compared with the magnetic records—very notably the great spot of October, 1865, engravings of which may be found in the volume of the *Proceedings* of the Royal Astronomical Society for the year last mentioned, as also the large groups of February, 1870, which were observed and drawn on the occasion of the recurrences by revolution of the same groups in the three consecutive months of February, March, and April of that year, and on the last of which months the total displacement, at one and the same time,

of the solar photosphere—or in other words, the total area occupied by the sun-spots—was no less than five thousand two hundred million square miles, or about twenty-seven times that of the superficies of the earth! So again in August and September, 1870, immense groups, occupying from four to five thousand million square miles, were observed to make two consecutive revolutions, and on the latter of which two occasions a beautifully enlarged photograph of the sun, twenty-four inches in diameter, was made by Mr. Titterton of Ely, under the auspices of the late Canon Selwyn, and exhibited to Section A. On all these occasions great magnetic disturbances, amounting often to absolute magnetic storms, were unequivocally manifested; and in fact out of twenty-four comparisons instituted, the following is the summary of results, as showing the coincidence of extensive solar activity and synchronous magnetic disturbances :—

Intensely	5	
Very decidedly	3	
Decidedly	9	= 21 affirmatively
Moderately	3	
Negatively (no spots, no storms) ...	1	
Questionable	1	
Contradictory	2	3 contradictory
	24	

Thus then, from the data collected, it would certainly appear that marked periods of solar activity are wont to coincide with marked periods of terrestrial magnetic disturbances; but yet from a careful comparison of the days and hours of the magnetic records appealed to, it also appeared that the disturbances were manifested in a variety of ways, not only as regarded the extent of the magnetic excursions of the needle, the rapidity of the oscillations, or the persistency of the more moderate disturbances, but also they were found to follow at considerably different intervals of time after the commencement of the observed solar outbursts. With respect, lastly, to reactionary influences, Mr. Howlett stated, on the authority of Mr. Whipple, the director of the Kew Observatory, that on the occasion of the perihelion passage of comet *b* 1881, on the 16th day of June last, the terrestrial magnetic curves were unusually quiescent.

On Artificial Flight, by Fred. W. Brearey.—The author proceeded to argue that the weight of the bird plays an active part in its flight, and that this result arises from the action of that portion of the pectoral muscle which depresses the wing. So great is the tension of this muscle that it is highly probable that, in the case of those long-winged and heavy birds which are able to fly without apparently moving a feather, the wings are kept extended against the resistance of the air underneath without any voluntary effort of the bird. Its weight pressing upon the air causes this muscle to expand in raising the wing, and aids in the effect of the downward stroke by its contraction. The author exhibited a model with wings 4 feet from tip to tip and 3 feet 2 inches from head to tail. The wings are moved by M. Penaud's plan of strands of india-rubber previously put into a state of tension, which in unwinding create a flapping of the wings. By an india-rubber cord attached to the under part of the wing and passing under the shaft to which the mechanism is attached an equilibrium between the two forces is attained; that is to say, the india-rubber strands are wound up to that extent that the wings in rising stretch the india-rubber cord—or, as the author calls it, the pectoral cord—until one force neutralises the other; so that, held in the hand, there is no action. When liberated, and committed to the pressure of the air, the weight of the model causes the wings to be elevated, and therefore stretches the pectoral cord, which in its contraction assists the power derived from the twisted rubber in depressing the wings against the weight of the model. During this action the flight is well sustained for 40 feet or more. The author states that an apparatus of the nature of a longitudinal parachute was liberated from a balloon which rose from Woolwich arsenal, and it travelled back, by the aid of gravity alone, to the arsenal, a distance of half a mile. From this he argued that if the fabric can be manipulated so that propulsion also can be imparted to it, then some encouraging results would be likely to follow. He showed a model of large size upon this principle, and how, by the action of the wing-arms, a wave is transmittted from head to tail along a loose surface in shape like a kite. This loose surface requires a fall before it can be inflated by the air underneath; the wave-motion of the wings is then found adequate to its propulsion.

On the Arrestation of Infusorial Life, by Prof. Tyndall.—Three years ago I brought with me to the Alps a number of flasks charged with animal and vegetable infusions. The flasks had been boiled from three to five minutes in London, and hermetically sealed during ebullition. Two years ago I had sent to me to Switzerland a batch of similar flasks containing other infusions. On my arrival here this year 120 of these flasks lay upon the shelves in my little library. Though eminently putrescible, the animal and vegetable juices had remained as sweet and clear as when they were prepared in London. Still an expert taking up one of the flasks containing an infusion of beef or mutton would infallibly pronounce it to be charged with organisms. He would find it more or less turbid throughout, with massive flocculi moving heavily in the liquid.—Exposure of the flask for a minute or two to lukewarm water would cause both turbidity and flocculi to disappear, and render the infusion as clear as the purest distilled water. The turbidity and flocculi are simply due to the coagulation of the liquid to a jelly. This fact is some guarantee for the strength of the infusions. I took advantage of the clear weather this year to investigate the action of solar light on the development of life in these infusions, being prompted thereto by the interesting observations brought before the Royal Society by Dr. Downs and Mr. Blunt in 1877. The sealed ends of the flasks being broken off, they were infected in part by the water of an adjacent brook, and in part by an infusion well charged with organisms. Hung up in rows upon a board, half the flasks of each row were securely shaded from the sun-the other half being exposed to the light. In some cases, more, over, flasks were placed in a darkened room within the house, while their companions were exposed in the sunshine outside. The clear result of these experiments, of which a considerable number were made, is that by some constituent or constituents of the solar radiation an influence is exercised inimical to the development of the lowest infusoria. Twenty-four hours usually sufficed to cause the shaded flasks to pass from clearness to turbidity, while thrice this time left the exposed ones without sensible damage to their transparency. This result is not due to mere differences of temperature between the infusions. On many occasions the temperature of the exposed flasks was far more favourable to the development of life than that of the shaded ones. The energy which in the cases here referred to prevented putrefaction was energy in the radiant form. In no case have I found the flasks sterilised by insolation, for on removing the exposed ones from the open air to a warm kitchen they infallibly changed from clearness to turbidity. Four and twenty hours were in most cases sufficient to produce this change. Life is, therefore, prevented from developing itself in the infusions as long as they are exposed to the solar light, and the paralysis thus produced enables them to pass through the night-time without alteration. It is, however, a suspension, not a destruction, of the germinal power, for, as before stated, when placed in a warm room life was invariably developed. Had I had the requisite materials I should like to have determined by means of coloured media or otherwise the particular constituents of the solar radiation which are concerned in this result. The rays, moreover, which thus interfere with life must be absorbed by the liquid or by its germinal matter. It would therefore be interesting to ascertain whether, after transmission through a layer of any infusion, the radiation still possessed the power of arresting the development of life in the same infusion. It would also be interesting to examine how far insolation may be employed in the preservation of meat from putrefaction. I would not be understood to say that it is impossible to sterilise an infusion by insolation, but merely to indicate that I have thus far noticed no case of the kind.

The Sun-Spot Period and Planetary Tides in the Solar Atmosphere, by F. B. Edmonds.—The author said that the influence of the planet may be localised on a surface or stratum of small thickness, so that the disturbing force would vary as the square of the distance of the planet. Under this supposition the predominance of Jupiter seemed to shut out the idea that sun-spot maxima and minima could depend simply on the opposition and conjunction of the planets. The consequence of such a supposition was not to be lost sight of, but may be taken together with the more general supposition that the attractive force is exercised on a gaseous envelope, of which the altitude is not insignificant. Again, the mass of the sun is acted on by the planets, and such parts as are fluid, whether in the liquid or

gaseous form, are subject to a disturbance of a tidal character as a matter of course. The author argued that a disturbing body would therefore raise a tide on the sun more than one hundred times greater than the same force would raise it if acting on a globe the size of the earth, the other circumstances being the same. Looking at the sun-spot numbers as a record of spring tides and as a first approximation, recognising only such tides as would be due to the conjunction and opposition of Venus and the earth, it remained to establish a relation between these tides and the tide due to Jupiter in the form of special tides varying in magnitude with the sun-spot numbers.

On a New Integrating Anemometer, by H. S. Hele Shaw and Dr. Wilson.—An ordinary Robinson's cup anemometer is used to drive a train of wheels and thus ultimately a serrated roller, which moves a board in the direction of, and with a velocity proportional to, that of the wind. On the board, which is horizontal and about two feet square, is placed a sheet of paper, upon which the roller presses, and in turning leaves the required trace, at the same time moving the paper underneath it. The board is prevented from having a rotary motion by means of a pair of frames, the upper moving by means of wheels on the lower, each of which can only move in one direction, and these directions are perpendicular to each other. By a clockwork adjustment the time element is able to be introduced, which, taken in connection with space, gives velocity. A method of performing this was shown, as also a proposed form of the instrument for observatories.

On a Universal Sunshine Recorder, by G. M. Whipple.—The author gave a description of a new form of card-supporter for the Campbell sunshine recorder. It consisted of a light frame capable of holding the slip of cardboard, to be burned by the sun in any position. It was arranged so as to receive ordinary parallel strips of card at all times of the year, and to allow of the instrument being employed on any part of the earth's surface without detriment to its efficiency. The card-holders themselves are movable, so as to permit of the cards being changed indoors or dried, if wet, before removal, in order to avoid mutilating the record of the observation. The instrument also has an appliance for placing the card correctly in position to receive the sun's image.

On the Calibration of Mercurial Thermometers by Bessel's Method, by Prof. Rucker.—The author stated that the late Mr. Welsh of Kew Observatory described to the British Association in 1853 the methods which he introduced of making and correcting mercurial thermometers. The correction with which the author dealt was that due to the variations in the bore of the tube. Mr. Welsh's method of making this correction, which is still employed at Kew, is less theoretically perfect than others, and has been unfavourably criticised abroad. The author, in conjunction with Prof. Thorpe, has recently corrected a number of thermometers with great care by Bessel's method, which is the most elaborate and perfect hitherto proposed. One set of three thermometers were made for them at Kew, and were calibrated according to Welsh's method. Afterwards the measurements necessary for the application of Bessel's method were made by the Kew authorities, the calculations being performed by the author and Prof. Thorpe. The Kew thermometers were thus subjected to the most rigorous possible test, and they were able to announce that in one instrument the errors left after the application of Welsh's method were not greater than four-thousandths of a degree Centigrade, and in no case did they exceed one-hundredth of a degree. As it is impossible to read on these thermometers less than a hundredth of a degree with certainty, Welsh's method, as applied at Kew, is practically perfect.

SECTION B—CHEMICAL SCIENCE

On a Process for Utilising Waste Products and Economising Fuel in the Extraction of Copper, by J. Dixon (Adelaide, South Australia).—This paper contains an account of a process for extracting copper from sulphurous ores, in which the heat generated by the combination of the oxygen of the air with the sulphur of the ore is utilised for the smelting of the ore. This process is based upon experiments, which, although the author regards as incomplete, show (1) that the charge grows visibly hotter by simply blowing air through it; (2) that the melting of the raw ore or regulus and its reduction can be carried on in the same furnace; (3) that if the ore is in lumps, and fed at the top whilst the air is admitted by the side, a practically clean slagg can be obtained; but if added in a coarse powder, as it is generally found in the market, it either blows out again or chokes the furnace; (4) that a rough copper of about 96 per cent. pure metal can be obtained by the successful working of this process.

On the Chemical Action between Solids, by Prof. Thorpe, Ph.D., F.R.S.—The author drew attention to the extremely rare instances of such action hitherto observed, showing how many of these might be explained on the supposition that combination actually occurred between the bodies either in solution or in a state of gas. For example, the formation of cement steel, by the combination of carbon with iron, which had long been adduced as an example of such combination between solids, was now explained by the fact that iron at a high temperature was permeable to gases, and that in the actual process of cementation oxides of carbon were formed, which were in reality conveyors of carbon to the metal. He then illustrated by experiments the formation of several compounds by bringing together the components in solid form, choosing as examples such as would manifest their formation by characteristic colouring. Thus, as instances, potassium iodide and mercuric chloride, potassium iodide and lead nitrate, and silver nitrate and potassium chromate, were powdered together in a mortar, and in each case evidence of an action was exhibited by the production of characteristic colours of the product of the reaction of these compounds. The author referred to the memoir of the Belgian physicist, Prof. Spring, on the same subject, some of whose experiments he had repeated and in the main confirmed. One of the most remarkable results obtained by the Belgian professor was the formation of coal from peat by subjecting the latter material to a high pressure. Peat from Holland and Belgium, when exposed to a pressure of about 6000 atmospheres, was, according to Spring, changed into a mass which in all physical characters resembled ordinary coal. Experiments of the same nature made by Dr. Thorpe with various samples of British peat yielded, however, a very dissimilar result. These experiments were made with pressures which were considerably less and more than those employed by Spring. Although solid, compact masses, hard and very much changed in structure, were attained, in no case was any product obtained which could be confounded with bituminous coal. He said it was highly improbable, on purely chemical grounds, that mere pressure had been little more than an important factor in the transformation of woody matter into coal.

Metallic Compounds containing Bivalent Hydrocarbon Radicals, Part ii., by J. Sakurai.—This is a continuation of the work, an account of which was given at the last meeting (NATURE, vol. xxii. p. 448, or *British Association Report*, 1880). *Dimercury methylene iodide*, $CH_2(HgI)_2$, is obtained by exposing methylene iodide with an excess of mercury to the action of light. It is a yellowish crystalline powder insoluble in ordinary solvents, but soluble in hot methylene iodide; it melts at 230° with partial decomposition. Iodine converts this compound into methylene iodine and mercuric iodide. This same compound is easily obtained by the exposure of the mono-mercuro-compound described last year (*loc. cit.*), mixed with mercury and mercuric iodide, to the sunlight. Hydric chloride reacts on dimercury methylene iodide, producing mercury iodomethide. The insoluble compound mentioned in the former publications (*loc. cit.*) the author regards $CH(HgI)_3$, and therefore contains a trivalent hydrocarbon radical. We have thus the following series of organo-mercury compounds :—

$$CH_3(HgI),\ CH_2(HgI)_2,\ CH_2HgI_2,\ \text{and}\ CH(HgI)_3.$$

On the Occlusion of Gaseous Matter by Fused Silicates at High Temperatures, and its Possible Connection with Volcanic Agency, by I. Lowthian Bell, F.R.S.

On the Siliceous and other Hot Springs in the Volcanic District of the North Island of New Zealand (with Photographic Illustrations), by W. Lant Carpenter, B.A., B.Sc., F.C.S. The author gives an account of his visit to this district in December, 1880; analyses of the water of many of the springs in the district are also given. The water of the springs in the neighbourhood of Lake Taupo were found to be chiefly siliceous; they are all more or less impregnated with free iodine, and possess a medicinal value. The water of one spring was found to be strongly impregnated with sulphates of iron and alumina. The water of the springs in the Hot Lake district of Rotona and Rotomahana contain large quantities of silica; the deposits from two of these form large siliceous terraces. The water of the springs in the White Island, which is the summit of an extinct volcano,